Preface

The art of gasification and pyrolysis of biomass is as old as our natural habitat. Both processes have been at work since the early days of vegetation on this planet. Flame leaping from forest fires is an example of "flaming pyrolysis." Blue hallow in a swamp is an example of methane gas formation through decomposition of biomass and its subsequent combustion in contact with air. Human beings, however, learned to harness these processes much later.

First, large-scale application of gasification for industry and society concentrated on coal as the fuel. It was primarily for lighting of city streets and affluent people's houses. Use of gasification, though nearly as ancient as combustion technologies, did not rise with industrialization the same as combustion because of the abundant supply and low prices of oil and natural gas. Only in the recent past has there been an upsurge in interest in gasification, fueled by several factors:

- Interest in the reduction in greenhouse gas emissions as a result of energy production
- Push for independence from the less reliable supply and fluctuating prices of oil and gas
- Interest in renewable and locally available energy sources
- Rise in the price of oil and natural gas

Several excellent books on coal gasification are available, but a limited few are available about biomass gasification and pyrolysis. A large body of peer-reviewed literature on biomass gasification and pyrolysis is available; some recent books on energy also include brief discussions on biomass gasification. However, there is a dearth of comprehensive publications specifically on gasification and pyrolysis; this is especially true for biomass.

Engineers, scientists, and operating personnel of biomass gasification plants clearly need such information from a single easy-to-access source. Better comprehension of the main aspects of gasification technology could help an operator understand the workings of the gasification plant, a design engineer to size the gasifier, and a planner to evaluate different options. The present book was written to fill this important need. It attempts to mold available research results in an easy-to-use design methodology whenever possible. Additionally, it brings into focus new advanced processes such as supercritical water gasification and torrefaction of biomass.

This book is comprised of nine chapters and three appendices, which include several tables that could be useful for the design of biomass gasifiers and their

components. Chapter 1 introduces readers to the art of gasification and its present state of art. It also discusses the relevance of gasification to the current energy scenario around the world. Chapter 2 presents the properties of biomass with specific relevance to gasification and pyrolysis of biomass. The basics of pyrolysis are discussed in Chapter 3, which also covers torrefaction. In addition, it introduces readers to the design of a pyrolyzer and elements of the torrefaction process.

Chapter 4 deals with an important practical aspect of biomass gasification—the tar issue. This chapter provides information on the limits of tar content in product gas for specific applications. It also discusses several means of reduction in tar in the product gas. Chapter 5 concerns the basics of the gasification of biomass. It explains the gasification process and important chemical reactions that guide pyrolysis and gasification. Chapter 6 discusses design methodologies for gasifiers and presents some worked-out examples on design problems. Chapter 7 introduces the new field of hydrothermal gasification, with specific reference to gasification of biomass in supercritical water. It covers the basics of this relatively new field.

One of the common, but often neglected, problems in the design of a gasification plant is the handling of biomass. Chapter 8 discusses issues related to this and provides guidelines for the design and selection of handling equipment. The production of chemicals and synthetic fuels is gaining importance, so Chapter 9 provides a brief outline of how some important chemicals and fuels are produced from biomass through gasification. Production of diesel and biogasoline is also discussed briefly here. Appendix A contains definitions of biomass and Appendix B lists physical constants. Appendix C includes several tables containing design data. The Glossary presents definitions of some terms used commonly in the chemical and gasification industries.

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